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(54) Slim tube funnel design with improved funnel

(57) A cathode ray tube has a glass envelope including a faceplate panel; a neck end; and a funnel connected between the panel and the neck end. The funnel has a main body portion and a yoke region, with the main body portion including at least one reinforcement rib. The reinforcement rib includes a curved ridge bend in the funnel that is curved outward away from a vacuum side of said funnel. Alternatively, the reinforcement rib includes a curved mound-like increase in thickness of the funnel. The curved thickness can be directionally oriented inwardly towards the vacuum side, outwardly away from the vacuum side, or both. The reinforcement rib can extend along the funnel in a direction from the neck end towards the faceplate panel, along the funnel in a direction transverse to that from the panel to the neck end, or a combination of both.

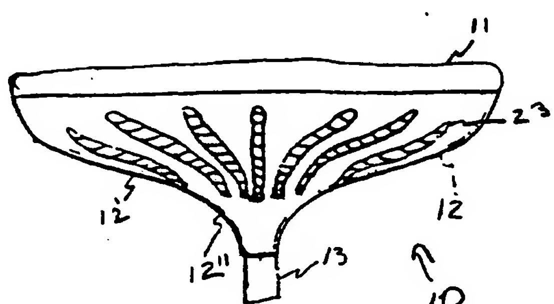

Fig. 1

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Description

Field Of The Invention

[0001] This invention relates generally to the field of cathode ray tubes, and, in particular, to the funnel portion of the cathode ray tube.

Background Information

[0002] Flat tube designs have necessitated changes in the design of glass envelope components used in a display tube. Flat tubes, for example, have required an increase of greater than one inch in the thickness of the glass in the center of the front faceplate panel. Further tube designs known as "SLIM" tubes have put additional stress constraints on the funnel portion of the tube. A SLIM tube is one where the axial depth of the tube is substantially reduced, compared to a conventional picture tube, especially in the funnel portion.

[0003] Making the front panel flat and reducing the depth of the tube has resulted in a need to increase the glass thickness of the tube to accommodate additional mechanical stresses. Although increased glass thickness has become an accepted industry practice, efforts are underway to reduce the amount of glass needed for the tube envelope. The funnel portion of the tube has always been about 50% of the weight of the tube, but the funnel is considerably thinner in cross-section than the faceplate panel because of the greater curvature of the funnel. Thickness distribution within the front faceplate panel and funnel are dictated by the strength and safety considerations in tube construction.

[0004] In a SLIM tube, the electron beam must be scanned over a wider deflection angle, compared to a conventional tube. For example, a conventional tube may have a deflection angle up to about 110 degrees, whereas a SLIM tube has a substantially larger deflection angle. The larger deflection angle is required because as the tube depth is reduced, electron guns are positioned closer to the front faceplate panel of the tube. The reduction of the tube depth is achieved by making the funnel portion and or the panel portion of the tube considerably shorter in the axial direction. As funnel depth is reduced, stresses in the funnel glass, caused by vacuum loading, are increased. The increased stresses result in a weaker tube envelope. Forces on the surface areas of the funnel, including the yoke portion, increase to where processing the funnels through frit application and exhaust cycles becomes difficult. Additionally, the glass areas on the funnel can become failure points during implosion testing. While it is economically desirable to provide a cathode ray tube having a reduced depth with minimal glass weight, stress and safety constraints must still be met.

[0005] The present invention is directed at reinforcement rib features in the glass funnel structure of a cathode ray tube. The rib features increase the tube's ability to withstand forces due to vacuum loading, manufacturing processes and safety testing, while keeping the tube weight minimal. The invention is especially useful in a SLIM tube design, or a tube with a large deflection angle, where the depth between the front faceplate panel and neck is reduced about 3 to 4 inches, compared to a conventional depth picture tube.

SUMMARY OF THE INVENTOIN

[0006] The present cathode ray tube has a glass envelope including a faceplate panel, a neck end, and a funnel connected between the panel and the neck end. The funnel has a main body portion and a yoke region, with the main body portion including at least one reinforcement rib. The reinforcement rib includes a curved ridge bend in the funnel that is curved outward away from a vacuum side of said funnel. Alternatively, the reinforcement rib includes a curved mound-like increase in thickness of the funnel. The curved thickness can be directionally oriented inwardly towards the vacuum side, outwardly away from the vacuum side, or both. The reinforcement rib can extend along the funnel in a direction from the neck end towards the faceplate panel, along the funnel in a direction transverse to that from the panel to the neck end, or a combination of both directions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a side elevational view of a cathode ray tube;
FIGS. 2-6 are cross-section views of inventive rib features in the glass of the cathode ray tube;
FIGS. 7-8 are side elevational views of cathode ray tube envelopes showing exemplary locations and orientations of the inventive rib features of FIG. 2-6.
FIG. 9 is a rear view along the line 9-9 in FIG. 8.

[0008] Similar reference characters refer to similar parts in each of the FIGURES of the drawings.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0009] FIG. 1 shows a cathode ray tube having a glass envelope 10, comprising a faceplate panel and tubular neck 13 connected by a funnel. The funnel 12 includes a main body portion 12' and a yoke region 12" sealed to the neck 13. A plurality of reinforcement ribs 23 are located in the main body portion 12' of the funnel 12. In a conventional tube, the glass sidewall in the yoke region 12" is made thick enough to accommodate the higher tensile stress in the yoke region 12". The main body portion 12 ', being much larger than the yoke region 12", is the logical area to remove glass and achieve substantial glass reduction. Therefore, thinning of glass in the main body portion 12' requires reinforcement against tensile

stress. The ribs 23 shown are oriented longitudinally from the neck 13 toward the front faceplate panel 11 along the main body portion 12'. Reference to rib 23 is merely exemplary. Other rib details 33, 43, 53 and 63 can be employed on the funnel glass alone or in combination with each other.

[0010] Referring to FIGS. 2-6, cross-section elevation views of different reinforcement rib configurations are shown. In the cross-section detail 20 of FIG. 2, an external reinforcement rib 23 in the glass is formed by a curved ridge bend in the glass directed outwardly away from the vacuum side 21 towards the outside or ambient air side 22 of the funnel. Preferably, bend transitions 24-27 to and from the rib 23 are gradual and curved, as opposed to acute angular changes where stress from vacuum loading would concentrate. The cross-section detail 30 of FIG. 3 shows a reverse ridge bend 33 curved inward toward the vacuum side 21 of the glass and away from the ambient air side 22.

[0011] In the cross-section detail 40 of FIG. 4, a rib 43 is formed by increasing the funnel glass thickness with a mound-like or curved protrusion extending inwardly towards the vacuum side 21 and away from the ambient air side 22. In the FIG. 5 cross-section detail 50, a rib 53 is formed by increasing the funnel glass thickness with a mound-like or curved protrusion extending outwardly in a direction away from the vacuum side 21 and towards the ambient air side 22 of the funnel. Lastly, in the FIG. 6 cross-section detail 60, a rib 63 is formed with the glass thickened with mound-like or curved protrusions 63 towards both the inside or vacuum side and the outside or ambient air sides 21, 22 of the funnel glass.

[0012] Additionally, exemplary locations and orientation of the reinforcement rib features of FIGS. 2-6 on the funnel portion of the cathode ray tube are illustrated in FIGS. 7-9. Each of the various rib configurations 23, 33, 43, 53 and 63 can be employed alone or in combination with each other on the funnel. For example, rib detail 23 and rib detail 43 can be located simultaneously at different locations on the same funnel glass.

[0013] In the cathode ray tube 70 of FIG. 7, the ribs 23 are oriented transverse to the longitudinal direction of the funnel surface. In cathode ray tube 80 of FIG. 8, there are ribs 23' oriented in the longitudinal direction along the funnel surface and ribs 23 oriented in a direction transverse to the longitudinal direction of the funnel surface. As can be seen from the rear view 90 in FIG. 9, taken along line 9-9 in FIG. 9, the transverse and longitudinal oriented ribs 23', 23 are configured in an exemplary hub and spoke pattern, but other interconnected rib patterns can be used.

[0014] The above described reinforcement ribs in the funnel glass surface make the funnel stronger and more resistant to impact and vacuum loads, as well as permitting the tube to withstand applied pressures during manufacturing processes and testing. In finite element analysis (FEA), stress models of tubes with the above ribs, incorporated into the funnel, stress due to vacuum load was shown to be reduced.

[0015] Curvature in the funnel portion of a typical tube serves to cause forces acting on the glass funnel to induce the greatest stress or strain in the direction of the glass surface. In a SLIM tube design where the depth between the front panel 11 and neck 13 is reduced, curvature in the funnel portion is reduced which tends to concentrate stress in funnel portions having greatest angular or directional change and induces greater bending stress in funnel portions that become less curved as the tube depth is reduced. Strains in the tube glass from vacuum loading are tensile in nature. Reducing these strains can be accomplished by the inventive rib features, shown in FIGS. 2-6, on the funnel. For example, where tensile stress induced by a vacuum is 1500 psi, incorporating ribs to the funnel glass can reduce that tensile stress to a level below 1000 psi, which is acceptable and safe.

[0016] The inventive reinforcement ribs properly located on the tube's funnel surface increase the tube's ability to withstand forces due to vacuum loading, manufacturing processes and safety testing. The rib features require a minimal amount of additional glass to achieve the added glass strength.

[0017] It will be apparent to those skilled in the art that, although the invention has been described in terms of specific examples, modifications and changes may be made to the disclosed embodiments without departing from the essence of the invention. Accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the true scope of the invention.

Claims

1. A cathode ray tube having a glass envelope (10) comprising:

   a faceplate panel (11);
   a neck end (13); and
   a funnel (12) connected between said panel (11) and said neck end (13), said funnel having a main body portion (12') and a yoke region (12"), said main body portion including at least one reinforcement rib (23).

2. The tube according to Claim 1, wherein said reinforcement rib comprises a curved ridge bend (33) in said funnel being curved inward toward a vacuum side (21) of said funnel.

3. The tube according to Claim 1, wherein said reinforcement rib comprises a curved ridge bend (23) in said funnel being curved outward away from a vacuum side (21) of said funnel.

4. The tube according to Claim 1, wherein said rein-

forcement rib comprises a curved mound-like increase (43, 53, 63) in thickness of said funnel.

5. The tube according to Claim 4, wherein said mound-like increase (53) in thickness is directionally oriented towards an ambient air side of said funnel.

6. The tube according to Claim 1, wherein said reinforcement rib comprises mound-like increases in thickness (63) in said funnel directionally oriented to both inside and outside of said funnel.

7. The tube according to Claim 1, wherein said reinforcement rib (23) extends along said funnel in a direction from said neck end towards said faceplate panel.

8. The tube according to Claim 1, wherein said reinforcement rib (23) extends along said funnel in a direction transverse to that from said panel to said neck end.

9. The tube according to Claim 8, wherein a first of a plurality of said reinforcement rib (23) extends along said funnel from said panel towards said neck end, and another plurality of said reinforcement rib (23') extends along said funnel in a direction transverse to that for said first plurality of said reinforcement rib.

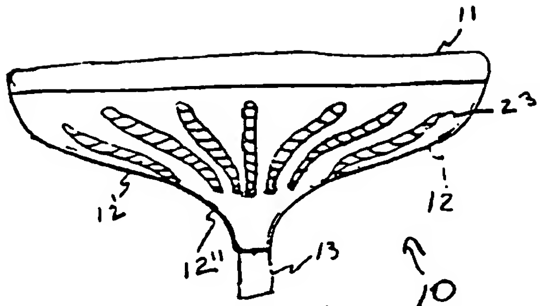

Fig. 1

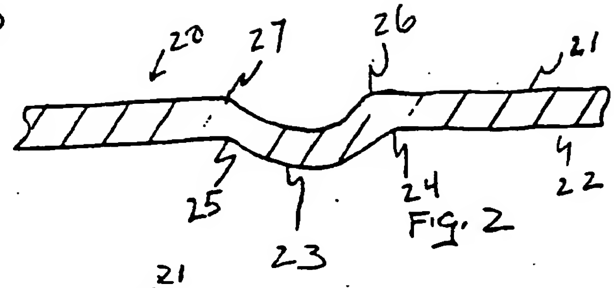

Fig. 2

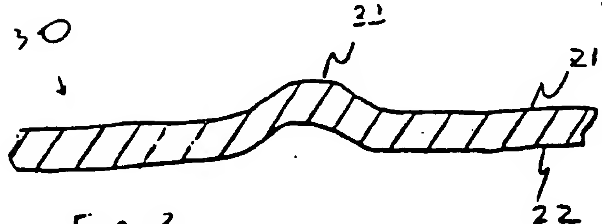

Fig. 3

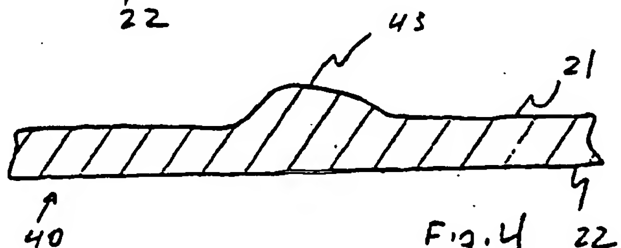

Fig. 4

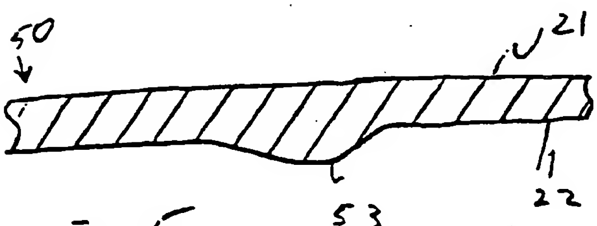

Fig. 5

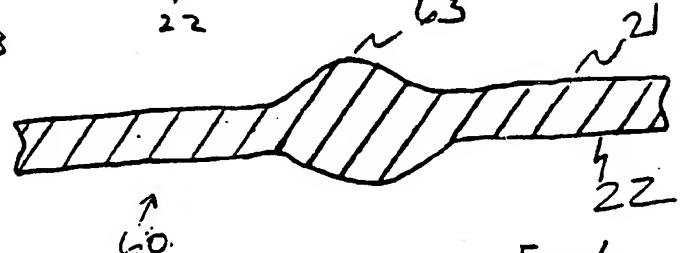

Fig. 6

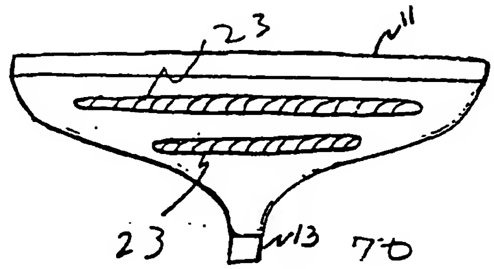

Fig. 7

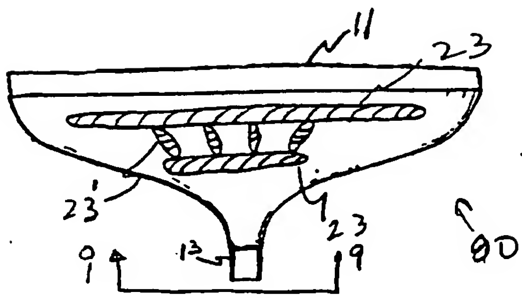

Fig. 8

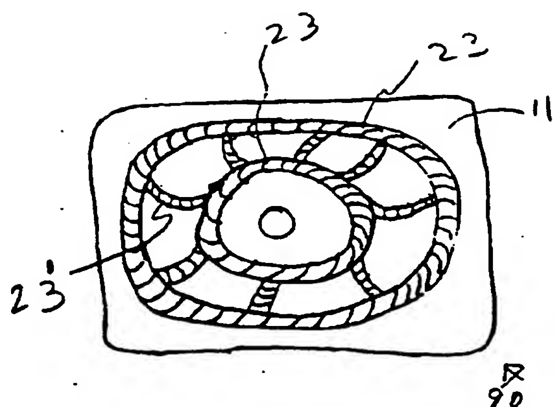

Fig. 9